CROP IMPROVEMENT AND ITS IMPACT ON THE FEEDING VALUE OF STRAW AND STOVERS OF GRAIN CEREALS IN INDIA

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CROP IMPROVEMENT FOR LIVESTOCK CROP-RESIDUE FEED AT ICRISAT ASIA CENTRE

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CONSIDERING the need to raise per capita food availability, one of the mandates of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) includes development of high yielding cultivars of pearl millet, sorghum, pigeonpea, groundnut and chickpea. However, in crops such as pearl millet and sorghum changes in the agricultural scenario have brought several changes in the breeding/selection programs. The importance of higher crop residue usage, particularly in sorghum and pearl millet, has been noticed recently. Research efforts in this area are limited at ICRISAT Asia Centre (IAC), since ICRISAT primarily aims at improving grain yields of its mandate crops to raise per capita food availability. We summarize below limited efforts put in on improving crop residues of its mandate crops for use as fodder.

Pearl Millet Improvement for Feed and Fodder

Pearl millet is a major source of fodder in India. It is important in drier areas where other cereal stover is not available for maintenance rations for cattle (e.g. western and central Rajasthan and northern Gujarat), and in higher rainfall areas where more preferred forages such as sorghum have problems with foliar diseases and stem borers (eastern Haryana and western Uttar Pradesh). It is also grown in parts of Gujarat where water availability is limited as an irrigated summer crop. Like the national program, ICRISAT's past work on pearl millet improvement in India has emphasized the development of high-yielding grain cultivars having early maturity, shorter plant height, and higher grain harvest indices than local

cultivars. In some cases, e.g. ICTP 8203, this approach appears to have resulted in lower yields of crop residues of lower fodder quality. In other cases, e.g., WC-C75 and ICMH 451 in northern India, the popularity of released cultivars has been due in part to farmer perceptions and/or superior stover quality, compared to other available alternatives. In still other areas, e.g. seed production of Pusa 23 and other hybrids based on male-sterile line ICMA 841 in Gujarat, farmer perceptions of good fodder yield quality of the hybrid seed parent itself facilitates hybrid seed multiplication and contributes to the ready availability of hybrid seed.

IAC's research in the last 10-12 years has begun to take greater account of the importance of pearl millet as a source of grain and stover for feed use. Economics surveys in Rajasthan have implicated inferior stover quality as a factor contributing to the limited adoption of improved pearl millets in Western and Central Rajasthan. (Kelley, et al., in press). In collaboration with scientists from the Central Arid Zone Research Institute and Rajasthan Agricultural University, We have attempted to involve farmers in identification of appropriate selection criteria - including perceived stover quality - so that products of pearl millet improvement programs will have a higher probability of adoption by farmers. High tillering ability, thin and soft stems are wanted by farmers who lack access to a forage chopper, but are less important to farmers with such access. We have examined the potential for selecting for higher rates of vegetative growth as a means to obtain higher grain and stover yields within a given length of growing season, and have used this as a selection criterion in some populations where our target is dual purpose genotypes. We have also initiated backcrossing programs to develop populations near-isogenic for a brown midrib gene that is expected to reduce lignin content of stover and improve performance of livestock fed with such stover. Once backcrossing is

completed, the potential utility of this character (and its possible negative effects on lodging) can be evaluated in locally adapted genetic backgrounds.

Pearl millet forage hybrids based on IAC-bred male-sterile lines have been developed by the national program in the Republic of Korea and by the private sector in India, but we have not evaluated such hybrids at IAC. Further, ICRISAT's breeding program on pearl millet x elephant grass hybrids in our regional program for Southern and Eastern Africa was transferred over to the national program in Zimbabwe several years ago as a costcutting measure. We do, however, have many pearl millet breeding populations and hybrid parental lines that could be evaluated as sources of high biomass, long-duration fodder genotypes.

In the realm of pearl millet grain for feed, ICRISAT has done little to date, except for a few poultry-feeding trials in collaboration with Andhra Pradesh Agricultural University, leaving this to others having greater expertise and interest. However, we are now exploring potential sources of the yellow-endosperm trait in pearl millet with the hope of identifying grain types having carotene contents similar to yellow maize. These would be of interest for use in livestock feed as well as for direct human consumption.

Sorghum Improvement for Feed and Fodder

Both sorghum grain and fodder as dry stalks or green forage, are fed to cattle. Until 1980s, grain received major attention in the sorghum improvement program at IAC, and many high-yielding seed parents with three- or four- and restorers with two- or three dwarfing genes were developed. As more and more marginal lands have come under cultivation, the availabilityof grazing land has declined and the demand for forage has increased, particularly in rainfed agriculture. So, the emphasis in the breeding program at IAC has shifted to dual-purpose sorghums intended for grain as well as fodder.

Some efforts are being made to diversify seed parents and restorers for height particularly towards two- and three-gene dwarfs in seed parents and one-gene dwarfs in restorers that can be used to produce taller hybrids with higher stover yields. Also, emphasis has been placed on improving the value of fodder by developing seed parents and restorers resistant to stem borer (Reddy et al., 1994; Sharma et al., 1994), anthracnose (Reddy and Singh, 1994a), downy mildew (Reddy and Singh, 1994b) and rust (Singh and Reddy, 1994).

Further, efforts are also being directed to diversify tillering sorghums which are amenable to multiple cuts. Hitherto, the sorghum seed industry has been dependent on introduced seed parents and pollinators for forage hybrids. The pollinators mostly belong to the Sudangrass type where variability is limited. So, to diversify the pollinators, (i) a new set of tillering breeding lines has been introduced from Southern African Development Community (SADC)/ICRISAT program, Zimbabwe, (ii) new tillering lines improved for thin stalk are being developed from crosses of Sudangrass and sweet-stalk lines, and (iii) a tillering population is being improved for non-pithiness and sweetness of stalk, and resistance to leaf diseases (Reddy, 1994). Together with other traits, data on grain and fodder yields in dual purpose sorghums and on fresh forage in forage sorghums are also recorded.

The IAC is also involved in a collaborative breeding program with various research centres of Indian Council of Agricultural Research (ICAR) aimed at producing multicut forage hybrids. The IAC contributes to the project by multiplying promising hybrids during postrainy season for several north Indian collaborators, to help in speeding up testing and evaluation of new forage hybrid combinations.

Improving early dual purpose population, for grain yield and biomass, tillering population for sweet stalk and biomass, and seed parents and restorers for resistance to various leaf diseases and stem borer will receive major emphasis in our future program. Also, IAC collaboration with ICAR in forage research will be continued.

Pigeonpea Improvement for Grain Yield

It is well known that the leftover grits, the by-product of 'dhal' milling industry in India and Eastern and Southern Arica, are used as feed for chicken and cattle. This by-product consists of primarily seed coat and broken cotyledons.

More recently in Americas (Venezuela, USA, Ecuador, and Brazil) tests are being conducted to use pigeonpea plants for controlled grazing, and silage making and to evaluate them as green fodder during dry season. We provided some germplasm for such evaluations. They were found to have good rejuvenation and ratoonability in crop livestock systems.

In the medium term program at IAC, the major task is to improve pigeonpea for grain purpose and we do not have any work to improve for feed and forage use.

Groundnut Improvement for Livestock Feed

Groundnut haulms are a valuable source of fodder or hay in Asia and Africa. They are valued particularly for high digestibility and protein and they are rich in nutrient content.

In most situations, the optimum time for haulm production will be well before the crop is harvested for maximum seed yield. As groundnut is grown mainly for seed purpose, haulm yield and quality, in general, do not receive attention in the crop improvement program. Only in areas where groundnut haulms are the main source of fodder

(Gujarat, and Rayalaseema region in A.P. in India), haulm yield and quality become important consideration in selection of a cultivar.

At IAC, data on haulm yield together with other characters such as resistance to leaf diseases are taken for entries in advanced yield trials. In few cases, haulm quality is also monitored. We will continue to monitor the haulm yield in advanced lines together with other characters in the medium term program at IAC.

Chickpea Improvement for Livestock Feed

The use of chickpea stalks for feed is of little significance. In rare cases, cattle is allowed to graze the field in early stages of crop development when there is excessive vegetative growth. Dried leaves (with malic and oxalic acid exudates) after harvest are used in some cases for mixing with other fodder to enhance the palatability of the feed. Crop improvement programs generally do not aim at breeding chickpea for crop residue. The literature search through Semi-Arid Tropical Crops Information Service (SATCRIS) (updated 16 Nov 1994) of 47534 documents did not retrieve any documents containing information, on crop residue use for feed of chickpea. In the medium term program at IAC, the chickpea program aims at the improvement of chickpea for grain yield and there are no plans to carryout research on crop residue.

International Agricultural Research Centers Effort

Further efforts in the Consultative Group on International Agricultaral Research (CGIAR) system are being directed to develop a system-wide initiative on livestock feed. In this, International Livestock Research Institute (ILRI) is taking the lead. It is expected that meetings will be held in India to formulate the proposal in the early part of 1995.

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